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1. Untranslatable words are replaced with asterisks (***).
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FULL CONTENTS

[Claim(s)]

[Claim 1] Carry out the clad of the sacrificial anode material to one field of a core material, and the aluminum alloy clad material which carried out the clad sets the brazing material of an aluminum-Si system to the field of another side of a core material, and [a core material] Mn: 0.5-1.5 % (it is below the sameweight %), Cu:0.2-0.6 %, With the aluminum alloy which consists of remainder aluminium and an impurity, contain Si:0.3-1.0 % and Mg:0.1 - 0.3 %, and it is constituted, and [sacrificial anode material] Mg: The aluminum alloy clad material for heat exchangers excellent in the reinforcement and corrosion resistance which are characterized by consisting of aluminum alloys which contain 0.3-0.6 %, Zn:0.5-2.5 %, and Si:0.3 - 0.6 %, and consist of remainder aluminium and an impurity.

[Claim 2] The aluminum alloy clad material for heat exchangers the thickness of sacrificial anode material excelled [aluminum alloy clad material] in the reinforcement according to claim 1 and the corrosion resistance which are characterized by regulating Mg of the impurity in an aluminum-Si system brazing material to 0.03% or less at 0.05mm or more.

[Claim 3] The thickness of an aluminum-Si system brazing material is 80 micrometers. Aluminum alloy clad material for heat exchangers excellent in the reinforcement according to claim 1 or 2 and the corrosion resistance which are characterized by being above.

[Claim 4] The aluminum alloy clad material for heat exchangers excellent in the reinforcement according to claim 1 and the corrosion resistance to which sacrificial anode material is characterized by containing one sort in Sn:0.01 - 0.1 %, or two sorts In:0.005-0.05% further.

[Claim 5] The aluminum alloy clad material for heat exchangers excellent in the reinforcement according to claim 1 and the corrosion resistance to which a core material is characterized by containing 1 of Ti:0.05 -0.30% and Zr:0.05 -0.30% of sorts, and two sorts further.

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention is soldering which uses the fluoride system flux in

inert gas atmospheres, such as an aluminum alloy clad material for heat exchangers especially a radiator, and a heater core. It is assembled and is related with the aluminum alloy clad material for heat exchangers excellent in the reinforcement and corrosion resistance which are suitably used as the header plate material of the heat exchanger made from aluminium for the automobiles through which water flows inside, and thin meat plate material.

[0002]

[Description of the Prior Art] Aluminum-ization of heat exchangers for automobiles, such as a radiator and a heater core, is promoted as part of an automobile weight saving. They are 1.2-1.6mm of total board thickness which made aluminum-Mn system alloy the core material, carried out the clad of the aluminum-Si system brazing material to the one side as header plate material of a radiator conventionally, and carried out the clad of the sacrificial anode material to other fields. The three-layer cladding material of the grade is used. Soldering joining is usually performed in an inert gas atmosphere using the fluoride system flux. aluminum-Zn alloy etc. is applied for the purpose of preventing pitting and crevice corrosion by cooling water of a working fluid as sacrificial anode material.

[0003] Weight savings, such as a radiator and a heater core, are demanded increasingly, importance is attached to raising the reinforcement after soldering heat for the thinning of tube material, and the request to corrosion resistance has also become strong in recent years for the life extension of an automobile. Generally, addition of Mg or Cu is validated at a core material or sacrificial anode material for the improvement in reinforcement of the cladding material for plates, and the various cladding materials containing Mg and Cu are proposed.

[0004] For example, a core material Mn: 0.3-2.0 %, Cu:0.05 -0.50%, Mg : 0.10 to 0.80% is contained. Constitute from an aluminum alloy which consists of the remainder aluminum and an impurity, and sacrificial anode material Mg:0.1-2.5 %, 0.3 - Cladding Material (JP,S62-45301,B) Constituted from an Aluminum Alloy Which Contains 2.0 % and Consists of the Remainder Aluminum and an Impurity A core material Mn:0.8-1.5 %, Cu:0.3-1 %, Si:0.6-1.3 %, Mg: 0.2-0.5 %, Zr : Contain 0.2% or less and it constitutes from an aluminum alloy which consists of the remainder aluminum and an impurity. Ingredient which contained Mg:0.2-0.5 % and Zn:0.1 - 0.3 %, constituted sacrificial anode material from an aluminum alloy which consists of the remainder aluminum and an impurity, and carried out the clad of the aluminum-Si system brazing material (JP,H1-4449,A) It is proposed. However, when the thinning of these cladding materials is carried out, the reinforcement after soldering heat should not necessarily satisfy them. If the natural electrode potential of a header plate serves as ** from the natural electrode potential of tube material, it stops being able to carry out corrosive protection of the outside surface of a tube and there is much Mg content of a core material, when there is much Cu content of a core material While it is spread while Mg solders, and a brazing material and the fluoride system flux react and a curdy compound generates Poor joining arises.

[0005] A core material Mn:0.3 - 2 %, Cu:0.25 - 0.8 %, Si:0.2-1 %, Mg : Contain 0.5% or less and it constitutes from an aluminum alloy which consists of the remainder aluminum and an impurity. Mg:1.2-2.5 %, Zn:0.5-2 %, and Si:0.2 - 0.8 % are contained for sacrificial anode material. It constitutes from an aluminum alloy which consists of the remainder aluminum and an impurity, and the cladding material which prepared the

aluminum-Si system brazing material is also proposed (JP,H4-193925,A). Set into this ingredient. It reacts with the flux of ** and a fluoride system which invades from an outside, a curdy compound is generated, and there is a trouble of reducing the airtightness of an O ring part.

[0006]

[Problem(s) to be Solved by the Invention] This invention cancels the trouble in the three-layer cladding material of an aluminum alloy, and is made as a result of having repeated a many-sided experiment and analyses about the connection of the combination of an alloy content, and many engine performance for the purpose of raising the characteristic further. The object is to offer the aluminum alloy clad material for heat exchangers which can be conveniently used as the aluminum alloy clad material for heat exchangers which aimed at the reinforcement after soldering, and betterment much more about corrosion resistance, especially a header plate for radiators, etc.

[0007]

[Means for Solving the Problem] [the aluminum alloy clad material for heat exchangers excellent in the reinforcement and corrosion resistance by this invention for attaining the above-mentioned object] Carry out the clad of the sacrificial anode material to one field of a core material, and the aluminum alloy clad material which carried out the clad sets the brazing material of an aluminum-Si system to the field of another side of a core material, and [a core material] Mn: 0.5-1.5 %, Cu:0.2-0.6 %, Si : 0.3 to 1.0%, With the aluminum alloy which consists of remainder aluminium and an impurity, contain Mg:0.1 - 0.3 %, and it is constituted, and [sacrificial anode material] Mg:0.3-0.6 %, Zn:0.5-2.5 %, and Si:0.3 - 0.6 % are contained. It is characterized [1st] by consisting of aluminum alloys which consist of remainder aluminium and an impurity, and the thickness of sacrificial anode material [0.05mm or more] The thickness of having regulated Mg of the impurity in an aluminum-Si system brazing material to 0.03% or less and an aluminum-Si system brazing material is 80 micrometers. It is characterized [2nd and 3rd] by being above, respectively.

[0008] Moreover, the thing for which sacrificial anode material contains one sort in Sn:0.01 - 0.1 %, or two sorts In:0.005-0.05% further, And a core material is characterized [3rd and 4th] by containing 1 of Ti:0.05 -0.30% and Zr:0.05 -0.30% of sorts, and two sorts further, respectively.

[0009] If the meaning and its Reason for definition of the alloy content in this invention are explained, Mn in a core material will function as making electric potential of a core material into **, enlarging electric potential difference with sacrificial anode material, and raising corrosion resistance while raising the reinforcement of a core material. It is 0.5 - 1.5 %, and the effectiveness of the desirable inclusion range is small, and if contained exceeding 1.5 %, as a result of a compound big and rough at the time of casting generating and injuring strip-processing nature, a healthy plate is difficult to get [the range] at under 0.5 %.

[0010] Cu functions as making electric potential of a core material into **, enlarging electric potential difference with sacrificial anode material, and raising the anticorrosive effect by a sacrificial anode effect while raising the reinforcement of a core material. The desirable content of Cu is the range of 0.2 - 0.6 %, and the effectiveness is small at under 0.2 %, and if 0.6 % is exceeded, a fusing point will fall and it will become easy to produce partial fusion in an interface with a wax at the time of soldering. From the

natural electrode potential of a tube, it becomes ** and the attack of a tube may be promoted.

[0011] Si generates an aluminum-Mn-Si system compound in a core material, and has the effectiveness of raising the reinforcement of a core material. Moreover, by coexisting with Mg, the detailed compound of Mg_2Si is formed and reinforcement is raised further. The desirable inclusion range of Si is 0.3 - 1.0 %, under its 0.3 % is not enough as the effectiveness, and when 1.0 % is exceeded, there is a possibility that a fusing point may fall and local melting may arise.

[0012] Mg has the effectiveness of raising the reinforcement of a core material. Moreover, by coexisting with Si, the detailed compound of Mg_2Si is formed and reinforcement is raised further. However, it is spread to the surface of a wax at the time of soldering, and there is an inclination which checks soldering nature, and in soldering which uses the fluoride system flux, since the fluoride of Mg generates and an appearance worsens, the inclusion range of Mg is made into 0.1 - 0.3 %.

[0013] It is divided into the field where concentration is high, and the field where concentration is low, and solidifies, and it is distributed in the direction of board thickness by turns with rolling, and becomes stratified, and the field where Ti concentration is high corrodes preferentially compared with the field where Ti concentration is low, and since Ti has the effectiveness which makes a form of corrosion stratified, it raises the corrosion resistance of a core material further. The desirable content of Ti is the range of 0.05 - 0.3 %, the effectiveness is small at less than 0.05%, if 0.3 % is exceeded, a compound huge at the time of casting will generate, and a healthy plate will no longer be obtained. In addition, even if Fe below 0.6 %, Zn below 0.3 %, and Cr below 0.3 % are contained in the core material, the effectiveness of this invention is not spoiled. Moreover, addition of 0.05 to 0.30% of Zr is useful for the improvement in reinforcement of a core material.

[0014] Contributing Mg in sacrificial anode material to improvement in the reinforcement of sacrificial anode material, the portion is diffused in a core material at the time of soldering, and functions on the improvement in reinforcement of a core material. If the desirable content of Mg is the range of 0.3 - 0.6 %, and the effectiveness is small at under 0.3 % and being contained exceeding 0.6 %, it will react with the flux of a fluoride system which invades from an outside, a curdy compound will generate, and the airtightness of an O ring part will be reduced.

[0015] Si reacts with Mg, forms Mg_2Si , and raises the reinforcement of sacrificial anode material. If the desirable inclusion range of Si is 0.3 - 0.6 %, under its 0.3 % is not enough as the effectiveness, and 0.6 % is exceeded, while superfluous Si will dissolve to formation of Mg_2Si and making electric potential of sacrificial anode material into **, self corrosion resistance is reduced.

[0016] Zn makes electric potential of sacrificial anode material **, and controls the attack of a core material according to a sacrificial anode effect. Desirable content is the range of 0.5 - 2.5 %, under its 0.5 % is not enough as the effectiveness, if 2.5 % is exceeded, the effectiveness which makes electric potential ** will be saturated, a self-attack will become intense, and early consumption of sacrificial anode material will arise.

[0017] Like Zn, In and Sn make electric potential of sacrificial anode material **, and control the attack of a core material according to a sacrificial anode effect. Desirable content is In:0.005-0.05% and the range of Sn:0.01 - 0.1 %, under its lower limit is not

enough as the effectiveness respectively, if an upper limit is exceeded, the effectiveness which makes electric potential ** will be saturated, a self-attack will become intense, and early consumption of sacrificial anode material will arise. In addition, even if Cu below 0.1 %, Fe below 0.3 %, Cr, Zr, and Mn are contained in sacrificial anode material, the engine performance of the cladding material of this invention is not affected. In addition, B can also be added to a core material for the miniaturization of ingot fabric.

[0018] In this invention so that the natural electrode potential of a header plate may not serve as ** from the natural electrode potential of tube material It is characterized by controlling Cu content of a core material, adding Si with Mg to a core material and sacrificial anode material, being the minimum Mg content and aiming at improvement in reinforcement after soldering by formation of a Mg_2Si compound.

[0019] From a core material, since the electric potential is **, the attack of a sacrificial anode material layer advances comparatively to a sacrificial anode material layer over a short period of time. The thickness of sacrificial anode material has desirable thickness of 0.05mm or more, in less than 0.05mm, consumption of sacrificial anode material becomes early extremely, and the penetration life of the whole cladding material falls.

[0020]

[Embodiment of the Invention] After the cladding material for heat exchangers of this invention carries out ingot making, for example by semi-continuous casting and carries out homogenization disposal about a core material and sacrificial anode material, it hot-rolls the aluminum alloy which constitutes a core material, sacrificial anode material, and a brazing material by the given thickness about sacrificial anode material and a brazing material, respectively. Subsequently, after combining each ingredient, considering it as a cladding material with hot rolling according to a conventional method and cold-rolling by the given thickness eventually, it is manufactured through the process which anneals eventually.

[0021] In order to manufacture a radiator by using the cladding material of this invention as a header plate Press forming of the aluminum alloy clad material of this invention is carried out, for example to the configuration of the header plate of a radiator, this is combined with a weld flat tube, the flux of a fluoride system is applied outside, and it is 3, for example at 605 ** in an inert gas atmosphere. It heats between parts and soldering joining is performed.

[0022] Therefore, in the cladding material of this invention, the clad of the aluminum-Si system brazing material containing Si:6-13% is carried out. A brazing material can also be made to contain one sort in less than Bi:0.2% and less than Be:0.2%, or two sorts in order to improve soldering nature. However, Mg as an impurity of regulating to 0.03% or less is desirable, and 0.02% or less of restricting is still more desirable. If Mg content exceeds 0.03%, it is easy to condense Mg oxide on the surface at the time of heat treating performed unescapable in the manufacture process of a cladding material, and this will react with the flux, and will shine, and a sex will be checked. Moreover, soldering nature is deteriorated in order to exhaust the flux, by the time a wax fuses in response to the time of soldering with the flux. It is still more desirable to restrict Mg content to 0.02% or less. The thickness of a brazing-material layer is 80 micrometers. The above is desirable and it is 80 micrometers. In the following, before a wax fuses, Mg of a core material is spread in a brazing-material layer, and soldering nature is reduced remarkably.

[0023]

[Example]

By work-example 1 continuous casting, ingot making of the aluminum alloy for core materials which has the composition shown in Table 1, and the aluminum alloy for sacrificial anode material which has the composition shown in Table 2 was carried out, and homogenization disposal was performed. Moreover, alloy (No.1), Si which consist of Mg:0.01 %, the remainder aluminum, and an impurity Si:7.8% as alloy for brazing materials: Ingot making of the alloy (No.2) which consists of Mg:0.04 %, the remainder aluminum, and an impurity was carried out similarly 7.9%.

[0024] The alloy for sacrificial anode material and the alloy for brazing materials were hot-rolled, it was considered as predetermined thickness, and clad rolling between heat was carried out combining the alloy for core materials. Then, it is 1.0mm in thickness by cold rolling and final annealing. The elasticity plate (refining O material) was produced.

[0025]

[Table 1]

材料 No	組 成(wt %)					
	Mn	Cu	Si	Mg	Ti	Zr
A	0.8	0.3	0.4	0.15	--	--
B	1.4	0.5	0.9	0.25	--	--
C	1.2	0.4	0.5	0.2	0.2	--
D	1.2	0.4	0.5	0.2	--	0.2

[0026]

[Table 2]

材料 No	組 成 (wt%)				
	Mg	Zn	Si	In	Sn
a	0.4	0.8	0.4	--	--
b	0.6	2.3	0.5	--	--
c	0.5	0.6	0.5	0.02	--
d	0.3	2.2	0.4	--	0.02

[0027] Clad plate carrying out press working of sheet metal to the configuration imitated in the header of the common radiator -- a weld flat tube (A4343 alloy wax of 30micrometer thickness --) A3003 An alloy core material and 40 micrometers A7072 of thickness The three-layer cladding material which consists of alloy sacrificial anode material, It combines with 0.3 totalmm in thickness, and is the fluoride system flux of non-corrosion behavior to an outside surface 5g/m2 It applies and is the retention time 3 at the temperature of 605 **. It processed by the part having cursed and the simulation

core was produced. To the simulation core, calking joining of the tank made from plastic was carried out through the O ring, the model core was produced, leakage examination and the visual inspection of the soldering part were conducted about this model core, and the cross section of the junction was investigated about what abnormalities were not accepted in. Moreover, about each cladding material veneer, soldering heat was carried out on the same conditions, and the tensile strength after cross-sectional examination and four-week neglect was measured.

[0028] About the model core abnormalities were not accepted to be by soldering, the SWAAT check was done as an outside corrosion resistance test, and the outside maximum attack depth was measured. Moreover, it is about the clad veneer with which abnormalities were not accepted by soldering, The sacrificial anode material surface (inner surface) which carried out soldering heat-treatment is made into an evaluating surface, and it is Cl⁻ - 100 ppm, SO₄²⁻ - 100 ppm, HCO₃⁻ - It is 10 ppm about 100 ppm and Cu²⁺. It is under [water-solution / which is included] setting. It is this water solution to 88 degrees C 8 Time heat was carried out, the immersion test of the temperature cycle which is neglected and is subsequently neglected to a room temperature for 16 hours was done for three months, and the maximum attack depth was measured.

[0029] The thickness of the combination of a core material, sacrificial anode material, and a brazing material, sacrificial anode material, and a brazing material, the existence of leakage, the situation of a soldering part, the tensile strength after soldering heat, and a corrosion-test result are shown in Table 3. As shown in Table 3, each sample board according to this invention of a soldering condition is good, and shows the tensile strength of 200 or more MPa after soldering, there is no leakage birth, and the maximum attack depth of an inner surface and an outside surface is 0.2mm. The following outstanding corrosion resistance was shown.

[0030]

[Table 3]

試験 材 No	犠牲陽極材		芯材	ろう材		漏れ 発生 の有 無	ろう付 状態	ろう付 後の引 張強さ MPa	最大腐食深さ	
	材 料	厚さ μm		材 料	厚さ μm				内面 mm	外面 mm
1	a	100	A	1	100	無	良好	200	0.10	0.15
2	b	100	B	1	100	無	良好	215	0.07	0.10
3	b	100	C	1	100	無	良好	205	0.07	0.08
4	b	100	D	1	80	無	良好	205	0.07	0.12
5	c	100	C	1	100	無	良好	210	0.10	0.10
6	d	60	B	1	100	無	良好	210	0.08	0.11

[0031] Ingot making of the aluminum alloy for core materials which has the composition shown in Table 4 by comparative example 1 continuous casting, the aluminum alloy for sacrificial anode material of the composition shown in Table 5, and the same alloy for brazing materials as a work example 1 is carried out, and they are the same conditions as

a work example 1, An annealing process is cold-rolled and carried out clad rolling between heat, and after that, and it is 1.0mm in thickness eventually. The elasticity clad plate (O material) was produced. About the obtained cladding material, the model core was produced by the same approach as a work example 1, and the same examination as a work example 1 and a check were done about this model core and the cladding material veneer. A result is shown in Table 6. In addition, the underline was given to what separated from the conditions of this invention in Tables 4-5.

[0032]

[Table 4]

材料 No	組 成(wt %)						備考
	Mn	Cu	Si	Mg	Ti	Zr	
E	<u>0.4</u>	0.3	0.4	0.2	0.06	—	
F	1.4	<u>1.2</u>	0.7	0.2	—	0.06	
G	1.0	<u>0.15</u>	0.8	0.3	—	—	
H	1.1	0.5	<u>1.2</u>	0.2	—	—	
I	1.6	0.4	0.1	<u>0.6</u>	—	—	
J	0.8	0.4	0.5	<u>0.07</u>	—	—	
K	1.2	0.2	0.1	—	—	—	3003合金

[0033]

[Table 5]

材料 No	組 成 (wt%)					備考
	Mg	Si	Zn	In	Sn	
e	<u>0.8</u>	0.3	0.4	0.02	—	
f	0.4	<u>1.0</u>	0.6	—	0.02	
g	0.3	0.3	<u>0.3</u>	—	—	
h	0.5	0.4	<u>2.7</u>	—	—	
i	—	0.2	1.2	—	—	
						7072合金

[0034]

[Table 6]

試験 材 No	犠牲陽極材		芯材	ろう材		漏れ 発生 の有 無	ろう付 状態	ろう付 後の引 張強さ MPa	最大腐食深さ	
	材 料	厚さ μm		材 料	厚さ μm				内面 mm	外面 mm
7	a	100	E	1	100	無	良好	190	0.11	0.10
8	a	100	F	1	100	無	不良 1	230	--	--
9	a	100	G	1	100	無	良好	190	0.10	0.12
10	a	100	B	1	70	無	不良 2	210	--	--
11	a	100	H	1	100	無	不良 1	220	--	--
12	a	100	I	1	100	無	不良 2	240	--	--
13	a	100	J	1	100	無	良好	190	0.11	0.11
14	e	100	A	1	100	有	良好	215	--	--
15	f	100	A	1	100	無	良好	210	0.45	0.16
16	g	100	A	1	100	無	良好	200	0.63	0.14
17	h	100	A	1	100	無	良好	205	0.47	0.15
18	i	100	K	1	100	無	良好	130	0.12	0.28
19	a	40	A	1	100	無	良好	200	0.59	0.16
20	b	100	B	2	100	無	不良 2	215	--	--

<<Table notes>> Leakage birth **: Leak and generate in a ring portion. Soldering condition Defect 1: It is local fusion at the interface of a core material and a brazing material. Defect 2: They are many void birth to the core of a fillet. [0035] Since sample board No.7 have few amounts of Mn of a core material, Cu, and Mg respectively, the reinforcement after soldering is inferior in them, so that it may see in Table 6. Since sample board No.8 and 11 had many amounts of Cu(s) of a core material, and amounts of Si(s) respectively, the fusing point of the core material fell and local melting produced them in the interface of a core material and a brazing material at the time of soldering. Sample board No.10 Since the thickness of a brazing material was thin, by the time the wax fused, Mg of the core material was spread to the brazing-material overburden part, and many voids arose in the fillet. Since sample board No.12 and 20 had many amounts of Mg of a core material, or amounts of Mg in a brazing material, much voids produced them in the fillet at the time of soldering.

[0036] Sample board No.14 Since there is much Mg content in sacrificial anode material, as a result of reacting with the flux, a curdy compound's arising and airtightness with an O ring part falling, leakage arose. Sample board No.15 Since there were many Si contents in sacrificial anode material, while the electric potential of sacrificial anode material rose, the self-corrosion rate increased, and the corrosion resistance of the inner surface fell. Sample board No.16 Since there were few amounts of Zn(s) of sacrificial anode material, a sacrificial anode effect was not enough and the corrosion resistance of the inner surface fell. Sample board No.17 Since there were too many amounts of Zn(s) of sacrificial anode material, the self-corrosion rate was large, the duration of the sacrificial anode effect became short, and the corrosion resistance of the inner surface fell.

[0037] Sample board No.18 Since core material alloy is 3003 alloy which does not contain Mg and sacrificial anode material is 7072 alloy which does not contain Mg, the reinforcement after soldering becomes inadequate. Sample board No.19 Since the thickness of sacrificial anode material was small, it originated in diffusion of Cu from a core material, and diffusion of Zn from sacrificial anode material to a core material, lowering of the electric potential difference between core material and sacrificial anode material arose, the sacrificial anode effect decreased, the duration of the sacrificial anode effect became short, and the corrosion resistance of the inner surface deteriorated.

[0038]

[Effect of the Invention] According to this invention, the aluminum alloy clad material for heat exchangers excellent in the reinforcement after soldering and corrosion resistance is offered. Especially this cladding material is suitably used as a header plate of the radiator for automobiles, and becomes possible [canceling a trouble peculiar to the header plate generated at the present radiator that leakage arises in a mechanical plane of composition with tank components].

[Translation done.]